FREEPORT-McMoRAN
COPPER & GOLD

Chino Mines Company
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Bayard, NM 88023

August 8, 2011

Certified Mail #70092250000154809938
Return Receipt Requested

Pam Homer
Standards Coordinator
New Mexico Environment Department
Surface Water Quality Bureau
P.O. Box 5469
Santa Fe, New Mexico 87502

Re: Development of Site-Specific Copper Criteria Work Plan
Smelter Tailings Soils IU - Chino Administrative Order on Consent

Dear Ms. Homer:

Freeport-McMoRan Chino Mines Company (Chino) submits the attached *Development of Site-Specific Copper Criteria Work Plan* for New Mexico Environment Department review and approval.

The Smelter and Tailing Soil Investigation Unit (STSIU) is one of the investigation units within Chino Administrative Order on Consent (AOC) Investigation Area (IA). Surface water in STSIU drainages has been determined to be a media of concern and a candidate for potential risk management actions with respect to aquatic life. Under the AOC, provisions addressing the identification, site-specific modification and application of surface water quality criteria in New Mexico's Administrative Code (NMAC) (20.6.4.900 NMAC) have been identified as pre-Feasibility Study (FS) Remedial Action Criteria (RAC) for surface water. These pre-FS RAC are considered as Applicable or Relevant and Appropriate Requirements (ARARs) for the purposes of the FS and subsequent remedial actions for the Chino Mine IA.

A preliminary review of water chemistry data from the Chino Mine IA indicates that many STSIU surface waters have water chemistries within the range previously demonstrated to modify copper toxicity. Additionally, the results from preliminary studies have confirmed that the toxicity of copper in STSIU surface waters is likely influenced by site-specific water quality conditions. The default hardness-based criteria, therefore, are not considered appropriate for application as ARARs to support the FS, and Site-specific Criteria (SSC) for copper are needed to support the development of an FS for STSIU surface waters. The studies proposed in this work plan will provide information needed to determine whether SSC for copper can be developed in STSIU surface waters.

Please contact Mr. Ned Hall at (520) 229-6470 if you have any questions regarding this work plan.

Sincerely,

Timothy E. Eastep, Manager
Environment, Land and Water

TEE:pp
Attachment
20110804-005
c Phil Harrigan, NMED
Jerry Schoeppner, NMED
Russell Nelson, EPA
Mark Purcell, EPA
Ned Hall, Freeport-McMoRan Copper & Gold Inc. (*via email*)
Pam Pinson, Chino (*via email*)

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Administrative Order on Consent Development of Site-Specific Copper Criteria Work Plan

Chino Mines, Vanadium, New Mexico

August 2011

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Administrative Order on Consent Development of Site-Specific Copper Criteria Work Plan

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Date: August 2011

Tables

Figures

Attachment

GLOSSARY

AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
AWWQRP	Arid West Water Quality Research Project
BLM	Biotic Ligand Model
COC	Chain of Custody
CMC	Criterion Maximum Concentrations
DOC	Dissolved Organic Carbon
FS	Feasibility Study
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
pH	Hydrogen ion (standard units)
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Plan
RAC	Remedial Action Criteria
RI	Remedial Investigation
SOP	Standard Operating Procedure
SSC	Site-specific Criteria
STSIU	Smelter/Tailing Soil Investigation Unit
SWQB	Surface Water Quality Bureau
USEPA	United States Environmental Protection Agency
WER	Water-Effect Ratio
WQC	Water Quality Criteria

1. Introduction and Background

On December 23, 1994 Freeport-McMoRan Chino Mines Company (Chino) and the New Mexico Environment Department (NMED) entered into an Administrative Order on Consent (AOC) to address the possible environmental impacts within the Chino Mine Investigation Area (IA), Grant County, New Mexico (the Site) due to mining operations, historical releases, and natural sources. The Smelter and Tailing Soil Investigation Unit (STSIU) is one of the investigation units within the defined IA. Copper is the primary contaminant of concern in STSIU, and surface water in STSIU drainages has been determined to be a media of concern and a candidate for potential risk management actions. The STSIU area encompasses 11 sub-watersheds, each composed of numerous tributaries that span steep mountainous terrain and remote locations (Figure 1 and Table 1). Collectively, over 100 miles of ephemeral tributaries are included within the STSIU network of sub-watersheds.

Under the AOC, provisions addressing the identification, site-specific modification and application of surface water quality criteria in New Mexico's Administrative Code (NMAC) (20.6.4.900 NMAC) have been identified as pre-Feasibility Study (FS) Remedial Action Criteria (RAC) for surface water. These pre-FS RAC are considered as Applicable or Relevant and Appropriate Requirements (ARARs) for the purposes of the FS and subsequent remedial actions for the Chino Mine Investigation Area, Grant County, New Mexico.

In accordance with Section 20.6.4.900 of New Mexico's Water Quality Standards, water quality criteria (WQC) for copper are calculated using a standard equation based exclusively on site-specific water hardness. Previous Site investigations, including the Site-wide Ecological Risk Assessment (Newfields 2005) and STSIU Remedial Investigation (RI) indicate exceedances of current hardness-based copper criteria in sub-drainage basins within the STSIU area. However, a variety of other physical and chemical characteristics of the water and the metal can influence metal toxicity to aquatic organisms in surface water (U.S. Environmental Protection Agency [USEPA] 1994, 2001). Multiple studies have demonstrated other water quality parameters such as

- pH and alkalinity,
- dissolved organic carbon (DOC) concentration, and
- percentage of humic acid in the aquatic humic substances

have equal or greater effects on copper toxicity than hardness alone (Arid West Water Quality Research Project [AWWQRP] 2006, Meyer et al. 2007).

A preliminary review of Site water chemistry data indicated that many STSIU surface waters have water chemistries within the range previously demonstrated to modify copper toxicity (i.e., elevated DOC, hardness, and alkalinity). Additionally, the results from preliminary studies have confirmed that the toxicity of copper in STSIU surface waters is likely influenced by site-specific water quality conditions. The default hardness-based WQC criteria, therefore, are not considered appropriate for application as ARARs to support the FS, and thus, Site-specific Criteria (SSC) for copper are needed to support the development of an FS for STSIU surface waters.

Acceptable criteria adjustment methods were thus evaluated for use in the development of copper SSC for surface waters in STSIU drainages. Based on a preliminary review of each method and site-specific conditions, Water Effect Ratio (WER) and Biotic Ligand Model (BLM) methods were determined to be most applicable because they are designed to explicitly account for the potential modifying effects of water chemistries on the toxicity of copper to aquatic organisms.

1.1 Objectives

The purpose of this work plan is to describe studies that can be used to support the development of SSC for copper in STSIU surface waters at the Site. The scope of this plan is thus targeted at the sub-drainage basins within the STSIU area. It is intended that this work plan will be reviewed and approved by the New Mexico Environment Department (through the Surface Water Quality Bureau [SWQB]).

Since there are limited opportunities to collect surface water in the STSIU drainages, and in order to develop the Feasibility Study, data needs to be collected in 2011. To accomplish this, a 2011 study plan will need to be reviewed and approved by the regulatory stakeholders by late August to allow for mobilization for sampling during the monsoon season (typically July to September). The study proposed in this work plan has been developed to collect the appropriate data set for a single season, to collect all data necessary to support multiple options for SSC development (e.g., BLM and WER), and thus to provide the data necessary to support SSC development. It is recognized that the data collection proposed in this work plan may not support all requirements for the development and adoption of a copper SSC for STSIU drainages, and that additional data may need to be collected. After the proposed data have been collected and analyzed, the results will be presented in a technical report that will identify any significant residual uncertainties and/or data gaps that would need to be addressed to support SSC development. At that time, the involved agencies will have the opportunity to comment on the sufficiency of the data and additional data required to support SSC development and ultimate adoption.

2. Conceptual Approach

A number of regulatory options are available for the development of site-specific criteria (SSC) that incorporate toxicity-modifying water quality parameters. Section 131.11 (b) (ii) of the water quality standards regulation (40 CFR Part 131) provides the federal regulatory mechanism for a State to develop SSC for use in water quality standards. Further, as a result of New Mexico's recent Triennial Review, provisions for the development of SSC are now available for application to State surface waters. As specified in Section 20.6.4.10, part D of New Mexico's Standards, SSC may be developed when physical or chemical characteristics at a site alter the bioavailability or toxicity of a chemical. In such cases a site-specific adjusted criterion may be developed using one of the following scientifically defensible methods:

- Water-Effect Ratio (WER) procedure - criteria adjustment based on the results of toxicity tests that are water chemistry dependent;
- Biotic Ligand Model (BLM) - criteria calculation based on complete water chemistry;
- Recalculation Procedure – criteria calculated only for the species that occur at the site; and
- Resident Species Procedure – combines WER and recalculation procedures (i.e., accounts for species sensitivities in site-water chemistry).

Acceptable criteria adjustment methods were evaluated for use in the development of copper SSC for surface waters in STSIU drainages.

A preliminary WER study was conducted in the summer of 2010 based upon several surface water samples collected in STSIU drainages to determine whether SSC adjustments for copper are warranted in surface waters at the Site. Results from this study may be used to supplement the development of copper SSC; but, studies were conducted to conceptually understand if current hardness-based criteria are appropriate in STSIU surface waters. Results from this study demonstrate the toxicity of copper is generally less in ambient site water than would be predicted using national water quality criteria (e.g., WER values greater than 1 were determined in multiple samples). This indicates that current hardness-based criteria for copper may be over-protective in some surface waters at Chino, particularly in drainages such as Rustler Canyon and Lucky Bill Canyon, where respective WERs in the range of 3 to > 10 were estimated. Results from this study also indicate a correlation between measured WERs and chemical parameters of the Site water including DOC, hardness and alkalinity.

A number of challenges associated with applying standard WER Guidance (USEPA 1994, 2001) to the STSIU area were identified during the planning and analysis of these preliminary studies. These challenges are discussed in the next section.

2.1 Site-Specific Challenges

As previously discussed, the STSIU area encompasses 11 sub-watersheds containing over 100 miles of small tributaries that span steep mountainous terrain and remote locations (Figure 1 and Table 1). From logistical and financial perspectives, it is not practical to develop empirical WERs for each reach of each tributary across all sub-watersheds in the STSIU area. Accordingly, application of standard USEPA WER protocol is challenging for several reasons, as described below.

1) ***Method Selection.*** Ambient copper in surface waters at Chino Mine Site originates from non-point sources that are believed to be associated with smelter fallout and wind-blown tailings. However, the

available USEPA WER Guidance documents (USEPA 2001 [Streamlined Copper] and USEPA 1994) are largely designed for point-source discharges to perennial water bodies. Method 1 of USEPA 1994 and the Streamlined Copper Method (USEPA 2001) are designed to determine WERs using simulated downstream water for application of copper discharges. In contrast, Method 2 of the 1994 Guidance is used to determine a WER for a large body of water outside the vicinity of plumes, and it can be very time-and-effort intensive (i.e., expensive). A modified sampling-and-analysis approach needs to be developed in conjunction with the State and USEPA because neither method is completely applicable to Chino's non-point source discharge scenario.

2) ***Site Conditions.*** Ephemeral tributaries in the STSIU area are characterized by extended dry periods with little to no flow in the channels and intermittent pools. Thus, for most of the year, surface water is not present in most streambeds, and locations of intermittent pools are dynamic in response to a flashy flow regime. This introduces difficulty in sampling consistent locations and narrows the sampling time frame to particular seasons, contrary to the 1994 Guidance. Therefore, a modified sampling-and-analysis approach would need to be developed in conjunction with the State and USEPA.

3) ***Sample Hold Times.*** As detailed in USEPA (2001), recommended sample hold times are 96 hours. However, these remote tributaries require substantial travel time to access, which presents a logistical challenge to starting WER tests within 96 hours of sample collection. Therefore, modified handling procedures would need to be developed in conjunction with the State and USEPA.

4) ***Ambient Copper in Toxic Range.*** Ambient copper in the toxic concentration range may prevent WER determinations if survival of test organisms in raw sample water is less than 50%. Although the 1994 Guidance discusses the possibility of using a reconstituted mimic of the site-water chemistry, it might be difficult to prepare a reconstituted mimic that matches the Chino site-water DOC (i.e., the standard, commercially available Suwannee River DOC might be challenged as unrepresentative of Chino DOC). Instead, use of a surrogate, non-toxic water from a STSIU drainage might be more acceptable. Options to address this challenge will be discussed with the State and USEPA.

5) Determination of WERs as water chemistry changes among water bodies. Because of the potentially wide range of water chemistry and remote areas with difficult access of water bodies at the Chino site, it would be beneficial to establish a way to determine WERs without having to conduct WER tests for every water body. One possibility would be to divide the water bodies into groups containing similar chemistry, with a WER determined for a representative water chemistry in each group (e.g., perhaps the most conservative condition in each group). Another possibility would be adopting a model that predicts WERs based on measured water chemistry parameters. A logical possibility is the BLM, if it can be demonstrated to predict WERs across a range of Chino waters. If that fails, another possibility is to use a multiple regression to predict WERs from several water chemistry parameters (e.g., alkalinity/hardness ratio and DOC concentration), with that regression being based on WERs determined from a set of representative Chino waters. None of these alternative approaches is mentioned in the 1994 Guidance, but that Guidance allows for some discretion to be applied to tailor a WER to site-specific conditions. Such options will be discussed with the State and USEPA.

2.2 General Approach

Based on a preliminary review of each method and site-specific conditions summarized in Section 2.1, WER and BLM methods were determined to be most applicable because they are designed to explicitly account for the potential modifying effects of water chemistries on the toxicity of copper to aquatic organisms. The BLM and WER methods are both potential approaches that could be used to develop copper SSC, according to 20.6.4.10 NMAC. However, because the standard BLM approach consists of a computer speciation model without empirical toxicity assays to validate model predictions, uncertainty may be introduced to a site-specific model that relies exclusively on BLM predictions. This uncertainty can be reduced by conducting empirical toxicity tests on water samples used as inputs to the BLM, as proposed herein.

On page 66 of the *Interim Guidance on Determination and Use of Water-Effect Ratios for Metals* (USEPA 1994), USEPA recommend testing the assumption that the WER correlates with a water quality characteristic across temporal and spatial scales. Based on the preliminary WER studies conducted, this assumption was supported by the results of a multiple regression of WERs with DOC, hardness and alkalinity. Thus, a modified WER approach is recommended to address BLM uncertainties and the challenges presented by deriving an empirical WER for each reach of each ephemeral tributary. Conceptually, this approach involves developing a robust WER model for determining empirical WERs over a subset of locations representative of all delineated tributary segments. The general proposed approach is outlined below and summarized in Table 2:

a. Empirical WERs will be determined in water samples collected from multiple drainage basins representing a large geographic and chemical range of waters. Additional surface waters will be sampled for chemical parameters that are correlated to copper toxicity and measured WERs. These additional surface water samples will be collected in multiple locations from each sub-watershed (Figure 1) to identify gradients in water chemistry parameters.
b. A multiple regression model will be developed between empirical WERs and water chemistry parameters. Based on preliminary WER studies, this model may be developed from DOC, hardness and alkalinity measured on sub-samples of water used in WER assays.
c. For tributaries or drainages (or stream reaches), empirical WERs determined within that tributary or drainage (or stream reach) over multiple sampling events will be used to derive a site-specific adjusted criterion. Depending on drainage-wide conditions such as water chemistry and number of tributaries, this empirically-determined criterion might be applied to the entire tributary or sub-drainage from which is was sampled.
d. Regression output will be used to predict WERs in other stream reaches or drainages not sampled for WER studies.

ARCADIS

e. Continued sampling will further refine and validate model predictions with additional WERs.

Because this approach consists of determining multiple empirical WERs in conjunction with measuring chemical parameters in additional locations, it should provide a better understanding of the spatial variability of site-specific toxicity and ranges of key water quality chemistries. Depending on the spatial variability of measured WERs and gradients in water chemistries, another alternative would be to develop empirical WERs to represent tributaries with similar water chemistries. This option can be evaluated based on the proposed sampling approach; therefore, it is anticipated that specific approaches may be modified as necessary based on technical review of the initial data collected. Using an iterative approach to the development of copper SSC will likely refine methodology to ultimately generate a more robust and technically-defensible dataset that can be used to develop site-specific criteria.

2.3 Specific Proposed Approach

The proposed approach for this work plan is comprised of the specific elements presented in this section. All sample collection, preparation, and testing procedures as well as all calculations will be conducted in accordance with the USEPA's *Region 6 Water Effect Ratio Study Checklist* provided as Attachment A, except in situations in which the State and USEPA approve deviations from the standard WER procedures.

2.3.1 Toxicity Testing

Toxicity tests will be used to develop copper WERs in STSIU surface waters. Methodology for toxicity testing will follow USEPA WER protocols (USEPA 1994, 2001) and the general whole-effluent toxicity testing methodology (USEPA 2002). The calculation of a WER is based on the following equation:

$$WER = \frac{\text{Site water LC50}}{\text{Lab water LC50}}$$

A WER is expected to take into account the (i) site-specific toxicity of copper and (ii) synergism, antagonism, and additivity associated with other constituents of the site-water (USEPA 1994). WER values that exceed 1.0 indicate that water quality characteristics of the site water reduce the toxic effects of copper below that predicted by the standard hardness-based criteria equations. Adjustments to the acute and chronic criteria are made by multiplying the hardness-based criterion value by the WER.

Toxicity tests in support of the development of WERs will be conducted for representative sites in STSIU drainages during the wet season (July – September). USEPA (1994) recommends intensive sampling during the two most extreme seasons to account for potential seasonal variations in water quality and metal bioavailability. However as previously described, it may be difficult to co-locate a sufficient number of samples throughout the wet and dry seasons, because most tributaries do not contain surface water during the dry season. Thus, two rounds of sampling are proposed during the wet season with a sufficient period of time between sampling events to characterize potential temporal variation. USEPA (1994) recommends a separation in sampling events of at least 3 weeks. However, this timeframe needs to be developed in conjunction with NMED's SWQB to reflect site-specific conditions including temporal extent of water in drainages.

2.3.2 Species for WER Toxicity Tests

USEPA guidance on species selection for WER toxicity tests is different between the Streamlined WER Method for copper (EPA 2001) and the Interim WER Guidance (EPA 1994). As specified in USEPA (1994), primary and secondary toxicity tests are conducted with taxonomically different species. In this approach, the secondary toxicity test serves as a confirmation of the WER results obtained from the primary test. In contrast, the secondary test is omitted from the Streamlined Guidance because "the additional test has not been found to have value." Inclusion of secondary WER toxicity tests in this criteria-adjustment plan will be determined based on feedback from NMED's SWQB.

Selection of a daphnid, such as *Daphnia magna*, as the primary test species is a logical choice given the breadth of available toxicity data, ease of culturing and testing, and their widespread acceptance for WER studies (USEPA 2001). In addition, when deriving a WER-adjusted criterion, it is important to use a test species such as *D. magna* that is sensitive at the criterion concentration (i.e., Criterion Maximum Concentrations, CMC) to which the WER is to be applied. However, the test endpoint in the laboratory dilution water (i.e., *D. magna* LC50 value) should not be lower than the criterion concentration. As a point of reference, the hardness-based acute criterion for dissolved copper in New Mexico is 13 µg/L at a hardness of 100 mg/L $CaCO_3$, and the geometric mean 48-hour LC50 of copper to *D. magna* listed in USEPA's (1984) copper criteria document (on which the New Mexico copper criteria are based) would be 40.7 µg/L at a hardness of 100 mg/L $CaCO_3$. Toxicity test methods are summarized in Table 3.

2.3.3 Water Quality Analysis

Conventional water quality parameters will be analyzed for each WER site and additional STSIU drainage locations. This information is intended to augment existing data, aid in the interpretation of toxicity test results, and potentially define spatial boundaries associated with WER sites (i.e., the spatial extent to which a WER-adjusted criterion applies). Additional chemical parameters that are included in the BLM will also be included in water quality analyses. Although BLM predictions of toxicity in Site water are currently tentative (i.e., BLM predictions need to be validated with site-specific toxicity studies), this additional water-chemistry information may contribute to the interpretation of toxicity results and provide additional weight-of-evidence to support development of site-specific criteria. The costs for obtaining these data will be relatively minor. The complete list of water quality parameters is presented in Table 4.

3. Proposed Study Design

USEPA WER protocols favor the development of a robust data set with a sufficient number of samples to quantify potential variability associated with seasonal effects and experimental variation. The recommended minimum number of sampling events and WER measurements varies between the 1994 and Streamlined Copper protocols: Method 1 of USEPA (1994) requires a minimum of 3 sampling events with a minimum of 4 WER measurements, whereas the Streamlined Procedure requires a minimum of 2 sampling events and 2 WER measurements. In contrast, Method 2 of USEPA 1994, which is designed for water bodies not influenced by a single point-source discharge, allows for greater discretion to be applied to sampling requirements to meet site-specific considerations: "Because each site is unique, specific guidance cannot be given… concerning either the selection of the appropriate number and locations of sampling stations within a site or the frequency of sampling." Instead, this method suggests incorporating all available information concerning the site to ensure the sampling plan spans the range of water quality characteristics that might affect the toxicity of the metal (USEPA 1994).

3.1 Sampling Locations

The proposed sampling plan is to perform dissolved copper WER testing on samples collected from multiple tributaries within STSIU sub-watersheds. The objective is to include a spatially-diverse set of geographic locations that span a range of chemical parameters that are correlated to WER measurements. Sites were selected with the intent of providing spatial coverage to represent the range of delineated tributaries within the STSIU network of sub-drainage basins.

Twelve stations have been selected in the STSIU area for the first round of WER toxicity tests. Table 5 provides a list of stations where it is proposed that samples will be collected during this study and Figure 2 shows the sampling locations.

3.2 Sampling Period

A sampling period beginning in summer 2011 is proposed for this work plan to overlap with the wet season. EPA guidance states that the selection of the number and timing of sampling events should take into account seasonal considerations, and that intensive sampling should occur during the two most extreme seasons. Because these drainages are dry for the majority of the year, two sampling events are proposed to coincide with the 2011 wet season to ensure the successful collection of water samples. These events are proposed to occur in late August and September, with a target timeframe to satisfy EPA's recommendation of a 3-week separation between sampling events. However, the specific period of time between sampling events needs to be determined in conjunction with NMED's SWQB as described previously.

The total number of WER measurements will ultimately be determined based on initial data collected and feedback from a technical review committee. Initially, a minimum of three successful WER measurements, as recommended in USEPA (1994), may be a reasonable target. However, because this recommendation is intended for perennial aquatic systems, a minimum of two successful WER measurements might be appropriate for these ephemeral drainages. Ultimately, this will be resolved through discussions NMED's SWQB.

4. Methodology

The field sampling and associated laboratory methodology are discussed in this section along with quality assurance/quality control procedures for this project.

4.1 Field Sampling Methods

Clean techniques, as described in Appendix C of USEPA (1994), should be used throughout all phases of the criteria-adjustment studies, including equipment preparation, water collection, handling and storage, toxicity testing and analysis. Use of such techniques will facilitate adequate analysis of trace metals and provide a robust data set that minimizes uncertainty related to sampling and handling error.

4.1.1 Water Collection

During sample collection, a multi-parameter data sonde (YSI 6900 series) will be used for in-situ measurements of pH, dissolved oxygen, conductivity, and turbidity. All water samples collected for WER studies and chemical analyses will be collected as grab samples taken at approximately the center of the pool or mid-stream at mid-depth. For collection of toxicity test samples, the appropriately-cleaned (acid-rinsed) cubitainer will be partially filled with Site water and shaken vigorously to pre-rinse the sample container with Site water, and this process will be repeated for a total of three rinses. Water to be used in toxicity tests will fill the sample containers; then the containers will be appropriately sealed with no head space above the water, labeled, and placed on ice until transported to the toxicity testing laboratory. Chain of custody (COC) forms will be included with transfer of samples from field personnel to the toxicity testing laboratory (GEI) and from field personnel to the analytical chemistry laboratory (ACZ).

Sub-samples of water collected for WER studies will be shipped directly from the field to ACZ laboratories for analysis of TOC, DOC, total and dissolved suspended solids, total and dissolved copper, alkalinity, and hardness. Knowledge of total and dissolved copper concentrations may be useful for determining spike concentrations for WER toxicity tests. Samples will be stored at 4°C, and Site water samples will be used in the toxicity tests as soon as possible after collection. Although the recommended maximum hold time is 96 hours, some samples may require additional time from collection to toxicity test initiation due to remote locations, time required for shipping, and pre-test copper analyses.

4.1.2 Preparation of Site Water

Raw Site water will be filtered through a 50 μm filter to remove potential predators and large debris (US EPA 1994). It may be appropriate to conduct subsequent filtration using a 0.45 μm filter size to remove particulate and colloidal matter that might affect copper solubility during the WER tests. Preliminary WER studies indicated potential solubility limitations for spiked concentrations of copper in some Site waters. Analysis of this data indicates that a significant amount of copper is potentially adsorbing to particulate or colloidal matter contained in raw Site water. Because the copper CMC to which the WER is applied is expressed as a dissolved concentration, it may be reasonable to filter Site water prior to assay initiation.

This step should be discussed with NMED's SWQB if solubility limitations are observed during the first round of sampling and toxicity testing.

4.2 Laboratory Methods

Standard methodology will be followed by the selected laboratories (GEI for toxicity testing and ACZ for analytical chemistry) for all of the sample preparation and tests. Specific details are presented below.

4.2.1 Laboratory Water Preparation

Standard USEPA reconstituted laboratory water listed in EPA (2002) will be used as laboratory control water in WER toxicity tests. Hardness values of the control water will be adjusted to the Site water hardness according to USEPA (1994). The control water hardness should be between 50 and 150 mg/L and lower than the hardness of the Site water, unless the hardness of the Site water is below 50 mg/L.

The goal will be to conduct the minimum number of concurrent laboratory control tests needed to support the interpretation STSIU surface water WER results. Although it is necessary to conduct side-by-side toxicity tests using Site and control water, it is acceptable to use a single control test for multiple Site water samples if water hardness can be matched as described above.

4.2.2 Chemical Analyses

The WER procedure recommends that copper in spiked Site-water samples be measured before the toxicity test begins and at the end of the exposure period, in order to calculate a time-weighted average of initial and final values. This approach will be followed for the proposed toxicity studies. In addition to dissolved copper measurements, total recoverable copper measurements will be included in the chemical analyses of toxicity water, as recommended by USEPA (1994).

4.2.3 Secondary Testing

At least one WER test will be performed with a secondary organism that is taxonomically different from the primary test organism, *D. magna*. The fathead minnow, *Pimephales promelas*, is a logical choice given its widespread use for acute toxicity tests and the fact that the STSIU sites are warmwater streams (thus arguing against the use of coldwater species like the rainbow trout). However, the selection of the organism and the timing of the tests will be determined based on review of the initial WER results and feedback from NMED's SWQB.

4.3 Quality Assurance/ Quality Control Procedures

An approved Quality Assurance Plan (QAP) for the Chino Mine investigation area (Chino Mine Company, 1997) contains detailed standard operating procedures (SOP) for the management, control and validation of data collected in support of the AOC. All sample collection, sample shipment, and chemical analyses described herein will adhere to methods detailed in the approved QAP (provided as Attachment B).

5. Data Evaluation and Reporting

Data will be evaluated for compliance with quality control criteria at the end of each sampling event. Data collected in the first round of sampling will be evaluated to identify remaining uncertainties or additional data needed to support the development of site-specific copper criteria in STSIU drainages. Based on this evaluation, the proposed study design will be modified as necessary to support a second round of sampling. It is anticipated that decisions regarding data acceptability and the need for additional data will be jointly reached with NMED's Surface Water Quality Bureau. A second round of sampling is proposed for the end of the wet season in September 2011.

All results will be summarized in a technical report and submitted to the technical review committee. The report will describe the overall study and clearly show the results from the toxicity testing and chemical analyses.

6. References

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USEPA. 2002. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, 5th ed. EPA-821-R-02-012. U.S. Environmental Protection Agency, Washington, D.C.

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Table 1
Delineated Watersheds Within the STSIU Area and Corresponding Acres and Drainage Lengths

Freeport-McMoRan Chino Mines Company
Vandium, New Mexico
Smelter/Tailings Soils IU Criteria Adjustment Work Plan

Watershed	Area (acres)*	Drainage length (miles)*
Lucky Bill Canyon	1097.8	3.5
Martin Canyon	4129.7	13.0
Rustler Canyon	2799.1	8.8
Subwatershed A	1961.4	5.8
Subwatershed B	3584.1	10.1
Subwatershed C	4709.2	13.3
Subwatershed D	6757.3	11.5
Subwatershed E	5000.7	15.4
Subwatershed F	1872.9	2.8
Subwatershed G	2800.9	8.3
Subwatershed H	4662.0	12.1
Total	**39375.0**	**104.6**

*Acres and drainage lengths of subwatersheds were calculated only for the delineated STSIU area shown in Figure 1.

Table 2
Summary of Key Challenges and Associated Proposed Resolutions/Approaches
Freeport-McMoRan Chino Mines Company
Vanadium, New Mexico
Smelter/Tailings Soil IU Criteria Adjustment Work Plan

Study Design Steps	Challenges	Resolution/Approach	Relevant Work Plan Section
Step 1: Select a WER method	USEPA WER Guidance (1994, 2001) is largely intended for point-source discharges to persistent waters. In contrast, Cu originates from non-point sources and water is present sporadically with limited persistence at the Site.	A modified sampling-and-analysis approach based on intent of USEPA (1994, 2001) WER Guidance is needed.	2.1
Step 2: Develop Study Design	**Sampling Locations:** The Site consists of over 100 miles of small drainages that are dry for most of the year.	Water will be collected at 12 locations that provide broad geographic and water-chemistry coverage.	2.1, 2.2, 3.1
	Sampling Period: USEPA (1994) WER Guidance requires a minimum of three water samples collected throughout the year at each site, but most streams in STSIU contain surface water only during the monsoon season (July – Sept).	Water samples will be collected only during the monsoon season (separated by at least 3 weeks, per USEPA Guidance). Details regarding total number of sampling rounds for final WER determination will be negotiated with the State and USEPA.	2.1, 3.0, 3.2
Step 3: Implement Study	**Sample Holding Time:** USEPA (2001) recommends a maximum hold time of 96 hr for receiving water used in WER tests. Sampling locations in STSIU are difficult and time-consuming to access, making it difficult to meet the holding-time recommendation. Additionally, preliminary chemical analyses and range-finder tests might be needed before WER tests can begin.	Water samples collected over several multiple-day periods will be shipped to the testing lab in batches, in an attempt to comply with the holding-time recommendation. However, samples from some difficult-to-access sites may still exceed the 96 hr holding time. Therefore, a relaxation of the holding-time constraint will be negotiated with the State and USEPA.	2.1, 3.0, 4.1.1
	WER Toxicity Tests: USEPA (1994) Guidance calls for the use of two test species. The primary test species (to be tested in all waters collected from the site) should not have an LC50 less than the applicable hardness-based Cu criterion. The secondary test species (only needs to be tested in one set of Site waters) is used to confirm WER results and its LC50 may be higher or lower than the hardness-based criterion concentration.	The candidate primary test species (*Daphnia magna*; a relatively sensitive aquatic invertebrate) and the candidate secondary test species (fathead minnow, *Pimephales promelas*; less sensitive than *D. magna*) will be tested in the first set of waters collected from the site, to ensure that at least one set of valid WERs is determined in that round. Any needed deviations from this WER Guidance will be negotiated with the State and USEPA.	2.3.1, 2.3.2, 4.2.3

Table 2
Summary of Key Challenges and Associated Proposed Resolutions/Approaches
Freeport-McMoRan Chino Mines Company
Vanadium, New Mexico
Smelter/Tailings Soil IU Criteria Adjustment Work Plan

	Site Water Preparation: In preliminary WER tests, the solubility of Cu appeared to be limited by the concentration and/or nature of suspended solids in the water. USEPA (1994, 2001) provide no guidance about dealing with problems caused by suspended solids.	If suspended solids cause problems in WER toxicity tests, water samples may be filtered (0.45 μm) to remove the solids. WERs calculated from tests conducted with filtered water should still be valid, because WERs determined in this study will be applied to dissolved Cu criteria (not to total-recoverable Cu criteria).	4.1.2
	Ambient Cu concentrations: Ambient Cu concentrations in some STSIU waters may be acutely lethal to *D. magna*, making it impossible to conduct a WER test to determine the LC50 (median lethal concentration) of Cu in that water.	Standard WER tests in which Cu is spiked into the receiving water to determine an LC50 will not be possible with these waters; instead, the waters will have to be diluted (as in a whole-effluent toxicity test) to determine the Cu LC50.	1.3
	Control Water Hardness: Standard WER guidance requires that the hardness of the laboratory control water used in the parallel lab-water toxicity test match the hardness of the Site water (unless the site-water hardness is not within the acceptable limit of 50-150 mg/L as $CaCO_3$). Because many waters are being tested and hardness will be determined at the time of sampling, it would be logistically prohibitive to test a hardness-matched laboratory control water for each Site water.	WER tests will be conducted with 2 laboratory control waters, one at a low hardness (50-75 mg/L as $CaCO_3$) and one at a higher hardness (125-150 mg/L as $CaCO_3$) to represent the likely range of acceptable hardness that need to be tested in the lab. Results of these tests will be used to extrapolate to the hardnesses of all the site waters.	4.2.1
Step 4: Calculate and Apply WERs	Follow standard USEPA (1994, 2001) Guidance for calculating WERs, except when deviations are needed to address unique conditions at STSIU.	Because surface water is not present during most of the year, WERs will be calculated from results of tests conducted on waters collected only during the monsoon season. As an alternative to developing individual WERs for multiple small drainages, a predictive regression-based model may be developed (using the WERs determined in the subset of waters tested during this study) to predict WERs from measured water chemistry parameters in STSIU waters. The use of the biotic ligand model (BLM) to predict WERs across the site will also be evaluated (if a BLM calibrated to the primary WER test species can accurately predict WERs in STSIU waters). Using either predictive model (or some combination), WERs will be developed for each stream reach in STSIU. It is expected that the final approach to WER determination will be negotiated with the State and USEPA.	2.1, 2.2, 4.2.1

Table 3

Test Conditions for Daphnia Magna 48-hour Acute Copper Water-effect Ratio (WER) Toxicity Test

Freeport-McMoRan Chino Mines Company

Vandium, New Mexico

Smelter/Tailings Soils IU Criteria Adjustment Work Plan

Method	EPA-821-R-02-012
Test Duration	48 hours
Sample Collection Procedure	Grab
Dilution Water	N/A
Acclimation	Cultured in moderately hard reconstitued water
Age of Organisms at Start	<24 hr. old
Feeding	None
End Point	Mortality
Type of Exposure Chamber	30 mL disposable plastic cup
Volume of Exposed Chamber	25 mL
Number of Animals Exposed/Chamber	5
Number of Replicates/Treatment	4
Test Temperature	20.0 deg C +/- 1.0 deg C

Table 4
Analytical Parameters for Proposed Toxicity Tests and Additional Surface Water Locations
Freeport-McMoRan Chino Mines Company
Vandium, New Mexico
Smelter/Tailings Soils IU Criteria Adjustment Work Plan

Constituent	Method	MDL (mg/L)	Sample Holding Time	Preservation	Volume Needed (mL)	Sample Container	Laboratory
Daphnia magna	EPA 600/4-91-002	N/A	96-hr*	--	2 gallons	1 gallon cubitainer	GEI
Metals, dissolved							
Aluminum, dissolved	M 200.8 ICP-MS	0.001	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Cadmium, dissolved	M 200.8 ICP-MS	0.0001	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Calcium, dissolved	M 200.7 ICP	0.2	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Copper, dissolved	M 200.8 ICP-MS	0.0005	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Iron, dissolved	M 200.7 ICP	0.02	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Lead, dissolved	M 200.8 ICP-MS	0.0001	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Magnesium, dissolved	M 200.7 ICP	0.2	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Manganese, dissolved	M 200.7 ICP	0.005	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Potassium, dissolved	M 200.7 ICP	0.3	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Sodium, dissolved	M 200.7 ICP	0.3	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Zinc, dissolved	M 200.8 ICP-MS	0.002	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Metals, total recoverable							
Aluminum, total	M 200.7 ICP	0.001	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Cadmium, total	M 200.7 ICP	0.0001	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Calcium, total	M 200.7 ICP	0.2	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Copper, total	M 200.7 ICP	0.0005	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Iron, total	M 200.7 ICP	0.02	180-d	HNO_3 to pH <3	251	251 mL	ACZ
Lead, total	M 200.7 ICP	0.0001	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Magnesium, total	M 200.7 ICP	0.2	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Manganese, total	M 200.7 ICP	0.005	180-d	HNO_3 to pH <3	251	251 mL	ACZ
Zinc, total	M 200.7 ICP	0.002	180-d	HNO_3 to pH <2	250	250 mL	ACZ
Water Quality parameters							
Alkalinity as CaCO3	SM2320B -Titration	2	14-d	$\leq$ 6 degree C	500	500 mL	ACZ
Carbon, dissolved organic (DOC)	SM5310B	1	28-d	Sulfuric acid, cool (4 degree C)	80	2X 40 mL VOA	ACZ
Carbon, total organic (TOC)	SM5310B	1	28-d	Sulfuric acid, cool (4 degree C)	80	2X 40 mL VOA	ACZ
Cation-Anion balance	Calculation		--	$\leq$ 6 degree C	500	500 mL	ACZ
Chloride	SM4500CL-E	1	28-d	$\leq$ 6 degree C	500	500 mL	ACZ
Hardness as CaCO3	SM2340B-Calculation	Calculation	180-d	$\leq$ 6 degree C	500	500 mL	ACZ
Residue, Filterable (TDS) @ 180 C	SM2540C	10	--	$\leq$ 6 degree C	500	500 mL	ACZ
Sulfate	375.4 - Turbidimetric	1	28-d	$\leq$ 6 degree C	500	500 mL	ACZ
TDS (calculated)	Calculation	Calculation	7-d	$\leq$ 6 degree C	500	500 mL	ACZ
TDS (ratio-measured/calcuated)	Calculation	Calculation	--	--	--	--	ACZ
pH	YSI data sonde	--	--	--	--	--	In-Situ
Temperature	YSI data sonde	--	--	--	--	--	In-Situ
Dissolved Oxygen	YSI data sonde	--	--	--	--	--	In-Situ
Conductivity	YSI data sonde	--	--	--	--	--	In-Situ

Notes:
*Extended sample hold time may be required for some WER samples.
TDS = Total dissolved solids
-- Not pertinent to this field

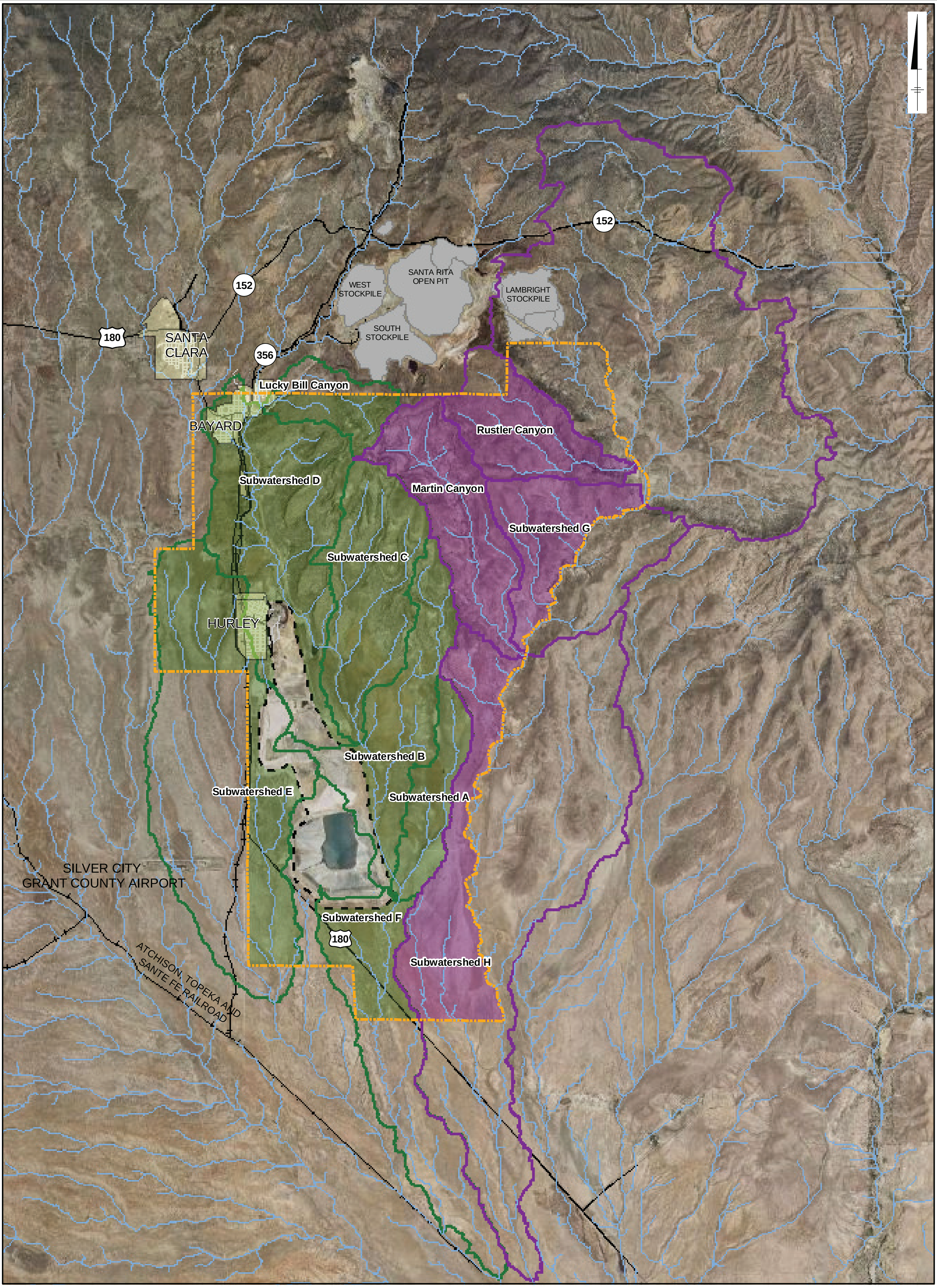
Table 5
Proposed Sample Locations for the First Round of WER Sampling and Testing

Freeport-McMoRan Chino Mines Company
Vandium, New Mexico
Smelter/Tailings Soils IU Criteria Adjustment Work Plan

Sample ID[1]	Sample Description	Longitude	Latitude
WER-1-1	Lucky Bill Canyon	-108.0967	32.7620
WER-1-2	Lucky Bill Canyon	-108.0920	32.7585
WER-1-3	D-1 drainage	-108.1145	32.7510
WER-1-4	D-2 drainage	-108.1142	32.7191
WER-1-5	C drainage	-108.1011	32.6973
WER-1-6	C drainage	-108.0899	32.7227
WER-1-7	B drainage	-108.0684	32.6872
WER-1-8	A drainage	-108.0627	32.6674
WER-1-9	Martin Canyon	-108.0479	32.6992
WER-1-10	Martin Canyon	-108.0564	32.7241
WER-1-11	G-drainage	-108.0272	32.7321
WER-1-12	Rustler Canyon	-108.0103	32.7433

Notes:
1. Sample ID nomenclature: Sample type - Sample round - Sample #

CITY: Lakewood DIV/GROUP: IM DB: MLM LD: PIC: PM: TM: TR:
Project #63524.001
Q:\FCX\Chino\2011\MXD\FS_STSIU\Subwatershed_Drainages.mxd - 8/8/2011 @ 2:25:03 PM



LEGEND:

- STSIU Study Boundary
- Drainages
- Lampbright Subwatershed Boundaries
- Lampbright Subwatersheds within AOC
- Hanover-Whitewater Subwatershed Boundaries
- Hanover-Whitwater Subwatersheds within AOC
- Smelter/Tailings Boundary
- Stockpiles
- Highway
- Railroad
- Town Roads
- City Areas

0 1.8 3.6 Miles

GRAPHIC SCALE

FREEPORT-MCMORAN CHINO MINES COMPANY
VANADIUM, NEW MEXICO

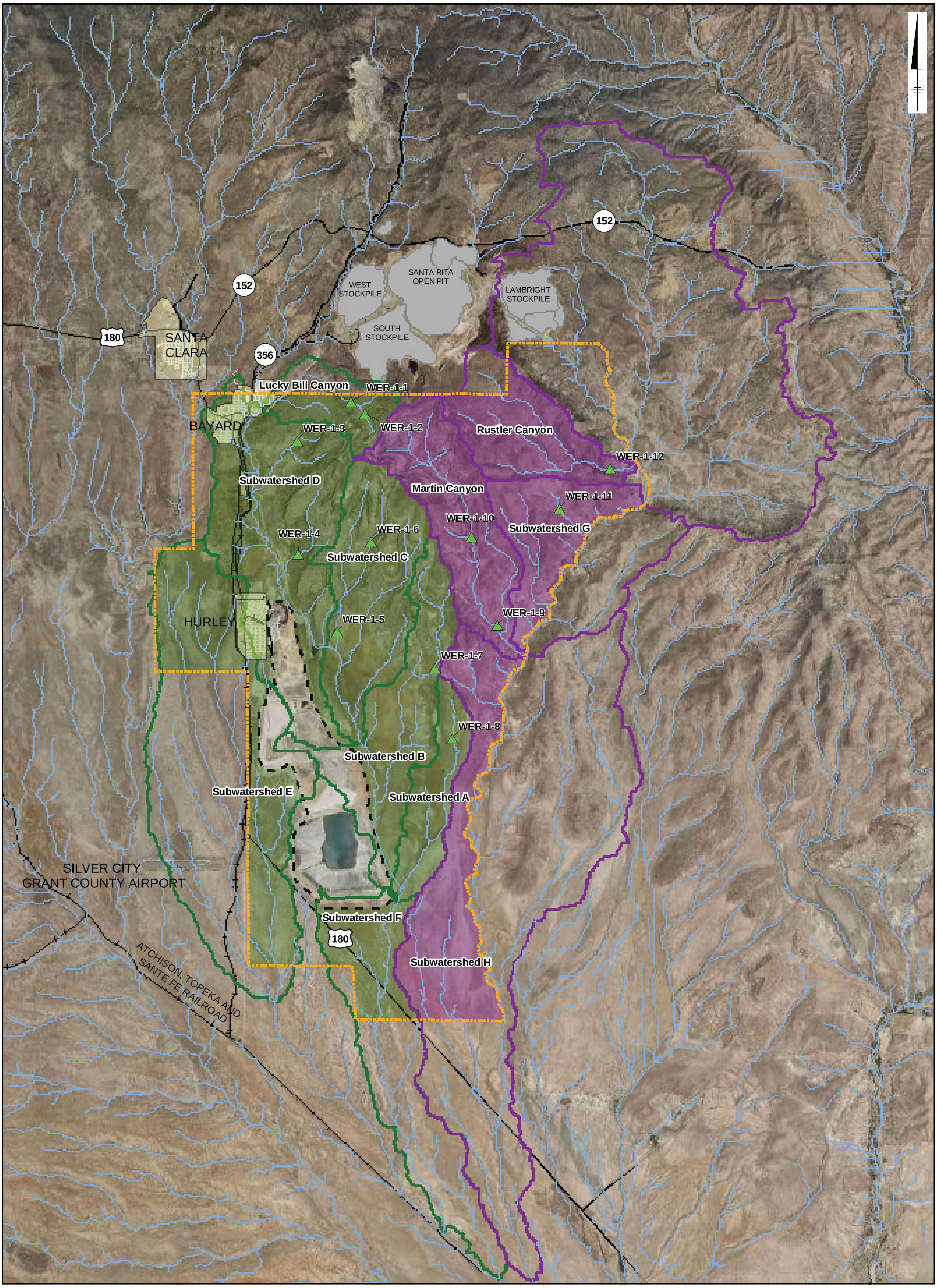
COPPER CRITERIA ADJUSTMENT WORK PLAN

SUBWATERSHEDS AND DELINEATED TRIBUTARY CHANNELS IN STSIU

ARCADIS

FIGURE
1

CITY: Lakewood DIV/GROUP: IM DB: MLM LD: PIC: PM: TM: TR:
Project #63524.001
Q:\FCX\Chino\2011\MXD\FS_STSIU\WER_SampleLocations.mxd - 8/8/2011 @ 3:49:00 PM



LEGEND:

- Proposed WER Sample Locations
- STSIU Study Boundary
- Drainages
- Lampbright Subwatershed Boundaries
- Lampbright Subwatersheds within AOC
- Hanover-Whitewater Subwatershed Boundaries
- Hanover-Whitwater Subwatersheds within AOC
- Smelter/Tailings Boundary
- Stockpiles
- Highway
- Railroad
- Town Roads
- City Areas

NOTES:

WER - Water Effect Ratio

0 1.8 3.6 Miles
GRAPHIC SCALE

FREEPORT-MCMORAN CHINO MINES COMPANY
VANADIUM, NEW MEXICO

COPPER CRITERIA ADJUSTMENT WORK PLAN

PROPOSED LOCATIONS FOR WER SAMPLES

ARCADIS

FIGURE
2

Water Effect Ratio (WER) Study Review Checklist

Permittee: ___________________________________ **Permit No.:** ________________________________

Date reviewed: _______________________________ **Reviewer:** _________________________________

*This checklist is based upon the 1994 Interim Guidance on Determination and Use of Water-Effect Ratios for Metals and applies to Method 1 described therein. The purpose of this checklist is to serve as a useful tool in reviewing Method 1 WER studies. The checklist does not supercede the 1994 Interim Guidance document. In reviewing a WER study, the acceptability of each toxicity test will be evaluated individually based upon the procedures described in the 1994 Interim WER Guidance. Page 57 of the 1994 guidance states that, "If the procedures used deviated from those specified in the guidance, particularly in terms of acclimation, randomization, temperature control, measurement of metal, and/or disease or disease-treatment, the test should be rejected; if deviations were numerous and/or substantial, the test must be rejected." Guidance concerning the calculation of the results of each test and the derivation of the individual test WERs and the FWER is also provided in the 1994 Interim WER Guidance. Review of these results will be in accordance with the guidance document***.**

General Information

#	**Question** *(If yes, place a "**Y**" in box; if no, place an "**N**" in box. If question cannot be answered in yes/no format, then place answer in "Comments" section.)*	**Workplan**	**Comments**	**1994 Guidance** page #, part
1.	Is the name, location, and description of the discharger provided?	☐		62, J(3)
2.	Is the name of the study investigator provided?	☐		62, J(1)
3.	Is the purpose for conducting the study described?	☐		–
4.	Are requirements that are in the existing permit concerning WET testing, TIE, and/or TRE being met?	☐		9
5.	Is pretreatment, waste minimization, or source reduction an option?	☐		9
6.	Are applicable technology-based limits being met?	☐		9
7.	Is a description of each sampling station provided?	☐		62, J(4)

Permittee:___________________________________ Permit No.:___________________________

Individual Studies

#	Question *(If yes, place a "**Y**" in box; if no, place an "**N**" in box. If question cannot be answered in yes/no format, then place answer in "Comments" section.)*	Study 1	Study 2	Study 3	Comments	1994 Guidance page #, part
Selecting Primary and Secondary Tests						
8.	Species used for primary toxicity test? (Write name.)	________	________	________		45-47, C
9.	Species used for secondary toxicity test? (Write name.)	________	________	________		45-47, C
Acquiring and Acclimating Test Organisms						
10.	Organism culture, hold, acclimation, feed, and handling protocols summarized?	☐	☐	☐		47-48, D(1-2)
11.	Were the organisms acclimated to site water prior to initiating the test?	☐	☐	☐		47, D(1)
12.	Were randomization procedures utilized?	☐	☐	☐		47, D(1) 53, G(9)
Collecting and Handling Upstream Water and Effluent						
13.	Was rainfall data or stream flow data included and was upstream water unaffected by recent runoff events? Rainfall data should be included.	☐	☐	☐		48, E(1)
14.	Is the effluent sample representative of normal operations?	☐	☐	☐		48, E(2)
15.	Was the plant operating at "normal levels"? Flow data should be included.	☐	☐	☐		49, E(5)
16.	Were samples stored at 0-4°C?	☐	☐	☐		48, E(4)
17.	Are chains-of-custody for samples included, accurate, and filled out completely?	☐	☐	☐		49, E(6)
18.	Were toxicity tests initiated w/in a maximum of 36 hours from the time of sample collection? Test initiation and termination times should be included.	☐	☐	☐		49, E(7) 62, J(1)
19.	If predators in the site water are a concern, was the site water filtered through a 37-60 µm sieve or screen?	☐	☐	☐		49, E(8)

Permittee:_____________________________________ Permit No.:___________________________

#	**Question** *(If yes, place a "**Y**" in box; if no, place an "**N**" in box. If question cannot be answered in yes/no format, then place answer in "Comments" section.)*	**Study 1**	**Study 2**	**Study 3**	**Comments**	**1994 Guidance** page #, part
Laboratory Dilution Water						
20.	Did the lab water have TOC and TSS <5 mg/L as required?	☐	☐	☐		50, F(2)
21.*	Was the hardness of the lab water between the required 40 and 220 mg/L?	☐	☐	☐		50, F(3)
22.*	Was the lab water hardness (w/in the above range) close to the site water? *From 1997 Guidance, page 3, next to last paragraph*	☐	☐	☐		<<1997 Guidance
23.	Are the lab water pH and alkalinity appropriate for the hardness used?	☐	☐	☐		50, F(4)
Conducting Tests						
24.	Was the spiking stock solution made from an appropriate reagent?	☐	☐	☐		50-51, G(4)(a-b)
25.	Was the same stock solution used for lab water and site water tests?	☐	☐	☐		51, G(4)(c)
26.	Was a static test run?	☐	☐	☐		51, G(5)
27.	If the test ran longer than 48 h, was it a renewal test?	☐	☐	☐		51, G(5)
28.	If it was a renewal test, were side-by-side tests renewed at the same time and were proper procedures for renewal followed?	☐	☐	☐		51, G(5)
29.	Was a range finder test conducted?	☐	☐	☐		51, G(7)
30.	Was the dilution factor used in the definitive tests of 0.65 or greater?	☐	☐	☐		53, G(8)
31.	Was an unspiked dilution water control for each test used?	☐	☐	☐		53, G(9)
32.	Were at least 20 test organisms per treatment used?	☐	☐	☐		53, G(9)
33.	Were two or more replicates used per treatment?	☐	☐	☐		53, G(9)

Permittee:_______________________________________ Permit No.: ______________________________

#	**Question** *(If yes, place a "**Y**" in box; if no, place an "**N**" in box. If question cannot be answered in yes/no format, then place answer in "Comments" section.)*	**Study 1**	**Study 2**	**Study 3**	**Comments**	**1994 Guidance** page #, part
34.	Were the laboratory hard water and the site water prepared in accordance with appropriate guidelines?	☐	☐	☐		53, G(10) 54, G(11)
35.	Were the test organisms (already acclimated), added to the test chambers for the side-by-side tests at the same time?	☐	☐	☐		54, G(12)
Chemical and Other Measurements						
36.	Were hardness (or salinity for marine water), pH, alkalinity, TSS, and TOC measured at test initiation for both site water and lab water?	☐	☐	☐		55, H(2)
37.	If "yes" to the above question, did the dissolved oxygen level remain acceptable throughout the entire test?	☐	☐	☐		55, H(3)
38.	Were dissolved oxygen, pH, and temperature measured for each treatment at the appropriate times during the test?	☐	☐	☐		55, H(3)
39.	Were both total recoverable and dissolved metal measured for all samples?	☐	☐	☐		54, H(4)
40.	Were the metal concentrations measured at the appropriate frequency?	☐	☐	☐		54, H(4)(d)
41.	Were QA/QC requirements summarized?	☐	☐	☐		57, H(4)(d)(5)
Calculating and Interpreting the Results						
42.	To prevent roundoff error in subsequent calculations, were at least four significant digits retained in all endpoints and WERs?	☐	☐	☐		57, I(1)
43.	Were greater than 10% of control organisms adversely affected (for acute tests)?	☐	☐	☐		57, I(2)(b)
44.	The percent of organisms that were adversely affected must have been less than 50%, and should have been less than 37%, in at least one treatment other than the control. Did this occur?	☐	☐	☐		57, I(2)(c)(1)

Permittee:____________________________________ Permit No.:___________________________

#	**Question** *(If yes, place a "**Y**" in box; if no, place an "**N**" in box. If question cannot be answered in yes/no format, then place answer in "Comments" section.)*	**Study 1**	**Study 2**	**Study 3**	**Comments**	**1994 Guidance** page #, part
45.	For lab water, at least one treatment showed at least 50% of the organisms to be adversely affected?	☐	☐	☐		57, I(2)(c)(2)
46.	For site water, at least one treatment showed at least 63% of the organisms to be adversely affected?	☐	☐	☐		57, I(2)(c)(2)
47.	Did a lower concentration kill a higher % of organisms than a higher concentration?	☐	☐	☐		57, I(2)(c)(3)
48.	If so, did this occur for more than two concentrations affecting between 20-80% of the organisms?	☐	☐	☐		57, I(2)(c)(3)
49.	If a static test was run, did the dissolved metal concentration at the end of 48 hours decrease by more than 50% from test initiation?	☐	☐	☐		58, I(2)(e)
50.	Did it increase by more than 10% from test initiation?	☐	☐	☐		–
51.	Did each individual test meet all acceptability requirements, as specified in #43-49 above?	☐	☐	☐		57, I(2)
52.	Were the LC50 (or EC50) values calculated appropriately and with similar statistics?	☐	☐	☐		58, I(4 & 6)
53.*	Was the hardness of the laboratory dilution water normalized (to obtain an adjusted LC50) according to the guidance document?	☐	☐	☐		39-43
54.	Do the results from the laboratory dilution water compare with results that were obtained using a comparable laboratory dilution water in one or more other laboratories?	☐	☐	☐		59, I(5)
55.	Is the WER larger than 5? If so, investigate results further as specified in the 1994 Interim Guidance on page 61.	☐	☐	☐		61, I(7)(c)(3)
56.	Were summary tables provided containing metal concentrations and organism response for each concentration?	☐	☐	☐		64, J(3)

Permittee:____________________________________ Permit No.:______________________________

Final Report

#	**Question** *(If yes, place a "**Y**" in box; if no, place an "**N**" in box. If question cannot be answered in yes/no format, then place answer in "Comments" section.)*	**Final Report**	**Comments**	**1994 Guidance** page #, part
57.	Were toxicity tests conducted at least three weeks apart?	☐		48, E(3)
58.	Three WERs for primary test developed?	☐		45, C(1)
59.	At least one WER for secondary test developed?	☐		45, C(1)
60.	Are the WERs obtained with the primary and secondary tests w/in a factor of 3? If yes, then results are further confirmed.	☐		61, I(7)(b)(1)
61.	Does the test with the higher endpoint give the higher WER? If yes, then results are further confirmed.	☐		61, I(7)(b)(2)
62.	Were both total recoverable and dissolved WERs calculated?	☐		60, I(6)
63.	Was the final WER calculated as the geometric mean of the three individual test WERs? Provide the final WER in the comments section.	☐		37-38
64.	Were acute and chronic criteria calculated? If yes, provide the results in the comments section.	☐		–
65.	Were any individual studies eliminated from consideration in the final WER calculation? If yes, provide an explanation.	☐		–
66.	Was an explanation of "unusual" observations and/or any procedural deviations provided if necessary?	☐		–

* As an alternative to conducting testing with laboratory water with a hardness between 40 and 220 mg/l total hardness and then mathematically adjusting the LC_{50} of the laboratory water to the segment regulatory hardness, testing can be conducted using laboratory water with the total hardness chemically adjusted to be the same as the segment regulatory hardness. If the laboratory water is adjusted, then no mathematical adjustment should be necessary.

Additional Comments: